

Cognition as a moderator of GDV emission: past research, a current explanation and some ideas for the future

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This article reports two research studies undertaken by the authors that have investigated the psychological correlates of the GDV technique. The results of these studies have been given elsewhere and obviously have not changed (see Dobson & O’Keeffe 2005, 2010). What has changed after over ten years of work in the area and with the benefit of hindsight is the interpretation of earlier results. Most would agree we believe that quite what the GDV measures when human subjects are involved is the key issue and one that has hampered the credibility of the technique. So after reporting the relevant results from our earlier work, this article presents our current “best guess” of what the GDV does actually measure when homo sapiens are tested.

Study 1: The GDV and Mental Stress

In 1999 we undertook a series of investigations into the impact of various stress therapies upon self-reported stress levels and GDV images. The basic research design for all the studies was to measure self-reported stress and the GDV image area before and then again after the intervention.

The Nature of Interventions & Samples

A wide range of interventions each led by an experienced tutor were included in the research:

- i) T’ai Chi involves relaxing exercises based upon gentle circular and rhythmic movements. The T’ai Chi sample included ten stressed office workers, and five HIV patients. These two groups have been analysed separately.
- ii) Kundalini Yoga involves demanding physical exercises mental concentration and spiritual discipline. The Yoga sample comprised fifteen self-selected individuals.
- iii) Meditation was undertaken with six self-selected individuals using this mental self-regulatory technique which aims to take practitioners beyond the usual state of wakefulness to a state of profound rest coupled with a new state of awareness.
- iv) Healing concerns the channelling of the universal life-force to restore energy balance within the body. A Tibetan lama used mantras and Tibetan rituals to channel healing energy with nine individuals. Mantras are Sanskrit words which have no denotative meaning and which are therefore free of distracting associations. Attention is focused on them as sound patterns which are believed to produce soothing and harmonious vibrations in the mind. Compared to meditation, which is a self-regulative exercise, healing is a passive process where the person is given treatment often without understanding its nature
- v) The Progressive Muscle Relaxation technique where the individual systematically tenses and then relaxes the body muscles was undertaken with nine self-selected stressed individuals.
- vi) A further ten self-selected office workers attended a typical Stress Management Training course which involved a variety of stress reducing techniques such as, visualisation, muscle relaxation, breathing control and aerobics.
- vii) Nine individuals attending The Stress Project in Islington underwent Acupuncture which aims to unblock body energy through intervention in energy meridians with fine needles.
- viii) The Unwinding group of nine individuals differed from the other interventions in that

they chose their usual day-to-day method of relaxation. They chose in more or less equal measure, smoking, drinking or meditation.

Finally the “Control” group was a group of fifteen self-selected post-graduate students at City University who volunteered to have their GDV image taken before and after a three hour lecture in either Organisational Behaviour or Applied Psychometrics. Whilst such lectures aim to achieve a higher state of consciousness, there is no particular reason to believe that they will reduce stress!

The total sample for the research therefore involved 82 reportedly stressed individuals distributed between 8 different types of intervention, and a “control” group of 15.

Results

Our first interest was in the relationship between the self-reported stress rating and the GDV image area. Neither before nor after the interventions was there any significant relationship between image area and self-reported stress levels: an individual who reported that they were feeling highly stressed might have a weak or strong GDV image. We can conclude that GDV image area is not an indicator of *self-reported* stress levels. This conclusion is supported by similar findings from a separate sample from the Ukraine where the correlation between self-reported stress levels and GDV area was also found to be insignificant.

However, when we investigated stress in a relative manner that looked at the change in stress levels before and after the interventions, very significant findings emerged. Namely, that a reduction in self-reported stress was significantly associated with a strengthening of the GDV area (with those who started with a fairly strong image showing less improvement), and no change in reported stress levels before and after the intervention was associated with no change or a small weakening of the GDV image. We conclude that whilst you cannot tell whether or not an individual *feels* stressed from their GDV images, an experienced reduction in reported stress levels is commonly associated with an increase in the GDV image area.

This finding also emphasises the importance of investigating the GDV on a case-by-case basis. There is a danger that averaging results across individuals will conceal effectiveness. Consequently Table 1 is based upon a case-by-case analysis. The finger images of each individual have been compared before and after the intervention and subjected to a paired-sample t-test to test the statistical significance of the change.

Table 1: Case-by-case analysis of the impact of stress intervention on GDV Area

	% Cases with statistically* significant increase in GDV finger images	% Cases with no change in GDV finger images	% Cases with statistically* significant decrease in GDV finger images
Meditation	66%	17%	17%
T'ai Chi	60%	30%	10%
Unwinding	57%	43%	0%
Progressive Muscle Relaxation	56%	44%	0%
Acupuncture	56%	33%	11%
Stress Workshop	50%	30%	20%
T'ai Chi (HIV)	40%	60%	0%
Tibetan Healing	33%	56%	11%
Control Group	25%	62.5%	12.5%

Kundalini Yoga	20%	53%	27%
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*probability of the change occurring by chance is less than 0.05.

The results show that the GDV image of most participants increased during the majority of the interventions designed to reduce stress. In many cases this was very visible and dramatic. As the table above indicates, highly significant subject differences were found. That is, the same intervention affects different people differently. For example, meditation appears to have a positive benefit for the majority, but no effect or a negative impact for others.

The final stage in our analysis of the data involved an investigation to see whether there were any significant individual or finger differences in response to these various interventions. No significant finger differences were found. That is, regardless of whether the overall change in finger image area was positive or negative, the impact tended to affect all the fingers equally. This points to a general metabolic or biophysical response, rather than a specific response where different fingers or finger sectors reflect different body systems.

Discussion of Study 1

We find evidence congruent with the idea that the GDV reflects a general metabolic and/or biophysical response. Other findings in Dobson & O’Keeffe 2005 support this idea, namely that skin temperature and heart rate were found to be significantly negatively associated with GDV area ($R = -0.51$ $p < .003$). Lazarus (1966) argues that the general metabolic response to stressful events commonly known as the fight-flight response results from our cognitive appraisal of the mental and physical demands of a situation and our appraisal of our ability to cope with such demands. The fight-flight response¹ involves physiological changes, for example, movement of blood supply away from the skin and smooth muscles to striate muscles, increased heart rate, increased skin sweating, and the release of stored blood glucose that combine to mobilise body energy and prepare for action.

We have also found a disjoint between subjectively reported levels of stress and the GDV. You cannot tell from the GDV image the level of stress an individual reports but significant and frequently visibly dramatic increases in GDV area are associated with individuals who report feeling less stressed after an intervention. It appears to be necessary to separate the physiological stress response from the reported emotional experience. This is in keeping with a large body of work on test anxiety, that is, those situations where individuals are subjected to objective evaluation of their abilities, for example by numerical or verbal reasoning tests or other forms of examination. Liebert & Morris (1967) proposed that test anxiety comprises two conceptually distinct components:

1. Worry - a cognitive concern over performance and its consequences, negative self-evaluations and negative task expectations;
2. Emotionality- physiological changes with unpleasant feelings of unease, nervousness and tension.

These two components appear to be conceptually and empirically distinct. Morris and Fulmer (1976) found that emotionality typically decreases significantly as the testing session proceeds, whereas worry does not. Morris et al (1981) following a review of the

¹ The fight-flight response was originally proposed by Cannon (1932). Nowadays it would be qualified to admit a freeze response and to recognize that fight-flight-freeze represent different behavioural and emotional responses and as Arnold (1960) suggests at least in detail they may have different physiological consequences.

literature concluded that “worry is the anxiety component most consistently and most strongly related (inversely) to academic performance, whether it be examination scores or course grades”. Whilst these two components are related, it would seem from our research that the GDV most likely directly reflects the physiological component of emotionality.

The classic work of Schachter & Singer (1962) on the role of cognition in emotion experience is relevant here. Research participants were administered adrenalin which increases arousal and has the diffuse physiological consequences of the fight-flight response. The participants were then asked how they were feeling. What Schachter and Singer found was that the reported emotions were significantly influenced by social cues from others. These others were stooges of the experimenters who modelled feeling happy, or anxious, or sad and so on. What this research shows is that the same physiological response can result in different experienced emotions. It would seem feasible that the individuals in our study could have had the same physiological response (and GDV image) but experienced different levels of stress, or vice versa.

Our research also reveals the impact of cognition on the GDV area. Most of the stress interventions involved some form of self talk or inner dialogue to “calm the mind”. One is struck by the similarity of our findings with a series of studies by Bundzen at al (many of which are given in Korotkov 2004) with athletes and sportsmen mentally preparing for competition, actors modelling emotional states, individuals undertaking mental tasks and the modelling of healing activity. These activities all involve mental concentration and what would colloquially be described as “getting into the bubble”. In contrast to our findings for stress reduction, this mental concentration and preparation significantly reduces the GDV area however it is possible that the same mechanism is involved. Preparing for competition increases arousal and mobilises body energy, whereas interventions such as meditation and Tai Chi aim to lessen arousal. In both cases the impact of conscious cognition on the GDV findings is clear.

Study 2: The GDV and Human Personality

This was an empirical study of the relationships between photon emission as measured by the GDV technique and the “Big Five” personality dimensions as measured by NEO-FFI (Costa & McCrae 1992). The NEO-FFI is aimed at the adult normal population and is amongst the most widely used and cross-culturally researched measures of personality. Samples in Russia (N = 35) and the UK (N = 42) completed the NEO-FFI and the GDV procedure administered by a trained GDV operator. The Russian version of the NEO-FFI was used for the Russian sample and different GDV machines and operators were used in the two countries. Despite this, a strong relationship ($R = .69, p < .000$) was found between the extent of photon emission as measured by GDV parameters and one of the “Big Five” personality dimensions, namely, Openness to Experience. This relationship held for both sub-samples when analysed separately (UK, $R = .60, p < .002$; Russian, $R = .53, p < .015$) and for all the fingers of both hands. The research also found some significant results for Extraversion but these were not as strong or as consistent as those for Openness. Insignificant results were found for the other three personality dimensions measured by the NEO, namely, Neuroticism, Agreeableness and Conscientiousness.

Table 2: Multiple Regression coefficients for the relationship between GDV Area & Intensity and Openness to Experience for UK & Russian samples by Finger averaged across both hands

Finger	Group	R
1.00	UK	.572
	Russian	.543
2.00	UK	.538
	Russian	.335
3.00	UK	.531
	Russian	.326
4.00	UK	.541
	Russian	.490
5.00	UK	.522
	Russian	.308

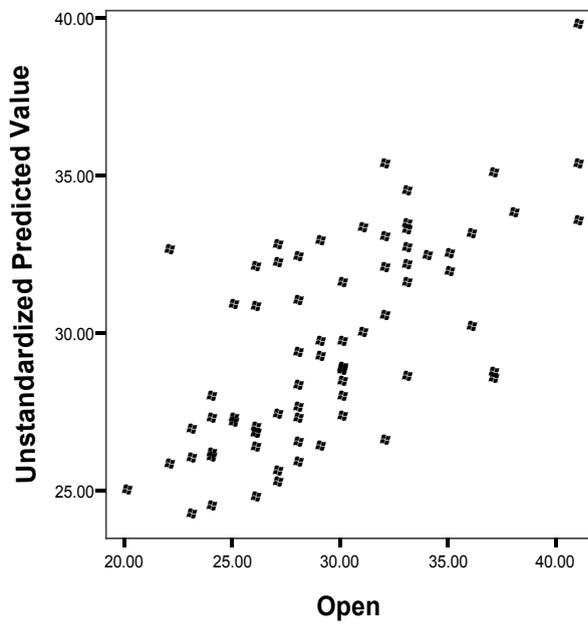


Figure 1: Scatterplot of GDV Area & Intensity with Openness to Experience

Discussion of Study 2

Personality can be defined as our characteristic ways of thinking, feeling and behaving. Personality dimensions are measured by and inferred from self report and are assumed to reflect underlying and relatively stable psychological constructs. The Big Five personality dimensions have been found across a vast array of studies using different instruments in different cultures and nowadays the majority of personality inventories report out in terms of these five dimensions. The dimensions of Neuroticism, Extraversion and Openness are reasoned, in part, to reflect genetic differences in neurological functioning with implications for how we characteristically perceive and respond to the world around us. For example, in whether we see social situations as stimulating or threatening and therefore, in Lazarus's terminology, the nature of our coping response; broadly speaking to approach or avoid. Personality therefore influences the way we *typically* appraise and think about events and in turn our behavioural and emotional responses.

Open individuals are characterized by Costa & McCrae (1992) as imaginative, adventurous, humorous, outgoing, curious, optimistic and excitable – open individuals appear to enjoy excitement and external stimulation whereas closed individuals characterized by the opposite behaviours appear to wish to avoid it.

In his book *The Biological Basis of Personality*, Hans Eysenck reasons that individual differences in Introversion-Extraversion are associated with genetically based differences in the resting level of arousal in the Reticular Activating System (Eysenck 1967). Introverts are reasoned to have a higher level of resting arousal than extraverts in the RAS which is a major pathway to the limbic system (the seat of many of our emotional responses) and higher cortical structures. Eysenck argued that this is the reason why introverts are socially inhibited whereas extraverts perform better in social situations, and introverts are more easily conditioned and show less performance decrement at vigilance tasks (repetitive and boring tasks such as crossing out all the zeros in a telephone directory). Eysenck's logic is clearer when we adapt Yerkes & Dodson (1908) who proposed the relationship between arousal and performance to be as given in Figure 2.

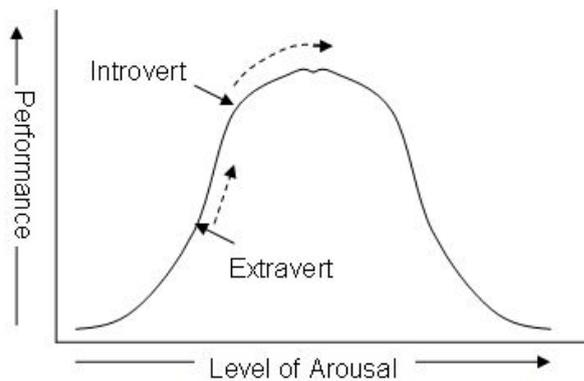


Fig.2. Introversiion-Extraversiion , arosal and performance

The extreme introvert having a high resting level of arousal performs best in less arousing situations and as arousal increases soon surpasses optimal performance levels and performance declines. In contrast, the extravert does not perform well in situations which lack stimulation such as vigilance tasks but as situations become more stimulating performance improves. Of course Eysenck refers to the dimension of Introversiion-Extraversiion not to Openness to Experience but what is important to note is that he used the Eysenck Personality Inventory in his research which does not measure Openness to Experience. Of interest is the significant correlation of 0.43 between Extraversiion as measured by the GDV/EPI and Openness to Experience as measured by the NEO reported by Costa & McCrae (1992).

In support of the view that it is Openness to Experience rather than or in addition to Extraversiion that reflects differences in arousal, DeYoung et al (2005) have reasoned that the fifth factor of Openness involves the limbic and autonomic systems and Costa and McCrae (1992) state that open individuals "experience both positive and negative emotions more keenly than closed individuals" also implicating mid-brain structures and the autonomic nervous system in individual differences in openness.

Conclusions

We have found that many interventions designed to reduce anxiety result in a strengthening of the GDV image. Other researchers working independently have found that mental work, modelling of emotional states by actors and mental preparation by athletes result in a weakening of the GDV image. These results point to a central role for cognition in determining the nature of the GDV image. Our conscious and perhaps also our unconscious thought processes appear to have a significant and often dramatic impact on photon emission. Our meditation, self-talk and imagination as well as our attempts at physical control and relaxation influence the GDV image. We have also found that the personality dimension of Openness to Experience is also related to GDV image area. Personality differences reflect relatively stable differences in the way we perceive and think about our worlds and respond to it. We have drawn on the psychological literature to suggest that Openness to Experience may reflect individual differences in arousal in mid-brain structures. Those who are more open to experience being less aroused respond positively to new, unfamiliar and stimulating challenges, whilst those characterised as more closed being more aroused prefer less arousing tasks and situations for fear of being over-whelmed. The level of arousal, from relaxation and inner calm to anxiety and high levels of concentration, seems to be a common theme linking the empirical studies and literature. A model linking thoughts, feeling and actions is given in Figure 3 below.

Figure 3: Cognition as a moderator of emotional, behavioural and physiological responses

What the model indicates is that sensory inputs take two paths. The first results in automatic reflex like physiological (and behavioural) responses which by-pass higher cortical centres. Homeostatic regulation and pupil dilation are responses of this type. The second path is via conscious and unconscious cognitive processes. It has long been known that we monitor events to which we do not consciously attend, for example, although we were not apparently listening we hear someone mention our name. Human beings appear to have an enormous capacity to unconsciously monitor stimuli which impinge on our senses. Novel, unexpected and meaningful events grab our attention and are consciously analyzed. Conscious thought influences how we respond to these stimuli; what we report about how we are feeling and what we choose to do in response and individuals of a particular personality will analyze, feel about and respond to events in distinctive ways. Cognition can also moderate our physiological responses. Just imagining an anxiety producing situation such as, giving a public presentation, standing on the edge of a cliff or a mouse running across the floor can result in the physiological responses associated with anxiety – our heart thumps, our breathing fastens and the throat gets dry. The evidence from yogis and biofeedback methods also suggest that we can consciously influence some physiological outcomes and of course sexual arousal has a cognitive component. It is not being suggested that we can selectively increase our blood sugar levels or dilate our pupils at will but rather that we can consciously trigger a bundle of physiological responses associated with say, fear, anger or sexual arousal and influence the intensity of these responses.

So how does the GDV image reflect our cognition and personality? First we have to address the key question of what does the GDV measure when human subjects are involved. The one thing that is certain is that the GDV image measures the extent of photon emission when human fingers are subject to an electromagnetic field. Why different individuals display a greater or lesser degree of photon emission or why the same individual displays a different image in different circumstances is open to debate. Our hypothesis is that the extent of photon emission is determined by body capacitance – the ability of the body to hold an electric charge. Our evidence comes from the relationship between capacitance of an object, in this case a metal cylinder placed directly on the dielectric plate of the GDV machine as is the case with human fingers², and the GDV area (Korotkov, 2008, fig.5.2 in this book). As can be seen in Figure 5.2, for a significant part of the range the GDV image area increases as

² Note that the procedure for liquids is different. Here droplets are suspended above the dielectric plate and in such cases GDV area reflects the strength of the electrolyte – distilled water shows little photon emission whereas strong solutions of NaCl reveal a relatively large GDV area (Korotkov & Korotkin 2001)

capacitance increases. As capacitance increases the voltage at which breakdown occurs increases resulting in a more intense gas discharge and greater photon emission.

So to return to our original question, we reason that cognition and personality influence photon emission because they influence our physiological responses which in turn affect body capacitance. Perhaps the physiological reactions that result in the mobilisation of body energy are key, for example, those that affect blood sugar levels and ATP production, but there may be a bundle of responses having effects on capacitance. This rationale is able to explain why physical relaxation, meditation, calming music and alcohol (it counteracts the effects of adrenalin) result in an increase in GDV image area; they reduce arousal, promote energy storage and increase capacitance. And why mental work by students, modelling of emotions by actors and preparation for competition by athletes result in a decrease in image area; they increase arousal, mobilise body energy and reduce capacitance.

Our thesis can also explain the research findings from investigations into the GDV and medical illness. Ill individuals typically display weaker GDV images than those who are healthy³. This may be for two not mutually exclusive reasons. First medical illness and disease may trigger directly physiological responses to mobilise body energy to fight the illness and in so doing reduce capacitance and the GDV image area. Second, emotions associated with illness such as anxiety and worry may have the same effect.

Finally, some ideas for future research. One rather obvious area for future research is experimental tests of the thesis we have advanced. Namely, some experimental evidence and a more detailed rationale that links the physiological correlates of fear, anxiety, concentration and other aroused states to a reduction of body capacitance. Further, additional evidence that the extent of photon emission is linked to capacitance rather than skin conductivity or permittivity would be welcome.

Our thesis suggests that the current research area of mental preparation for sports competition is likely to bear fruit especially if different sports are factored into consideration; the mental preparation for a marathon is likely to be different to that effective for a 100 metres sprint. The development of this area into the self-talk and envisioning strategies used by sports people to prepare for competition appears an interesting future direction as does the broadening of the area into mental preparation for everyday demands such as making someone redundant, giving a sales presentation, going for a job interview, dealing with a difficult client and so on. Most people find these types of situation challenging and some if not most engage in some self-talk as preparation. There already exists a sizeable body of relevant literature in the area of assertiveness (for example, see Back & Back 1999) but the GDV may offer additional insights into the effectiveness of different strategies in coping with these demands; especially if as one would suspect there are individual differences confounding the effectiveness of alternative strategies.

Current research into the GDV and an individual's ability to cope with physically and mentally demanding roles would also seem an appropriate avenue for the future. The GDV has and can be usefully employed to monitor the individual reactions of arctic explorers, astronauts, fighter pilots, special forces, submariners and so on, and to track their adaptation to these extreme conditions over time.

³ Our earlier research did find evidence that the GDV can distinguish ill individuals from healthy individuals better than would be expected by chance. However, we were not able to provide any evidence that the GDV can diagnose specific illness or malfunctioning. In all our research studies the GDV has been found to reflect a general response that affects fingers, sectors and hands more-or-less equally.

A further area for research would be the use of the GDV as an alternative to the GSR (or polygraph or lie detector). Although the GDV is moderately correlated with skin conductivity it is not measuring the same thing. Rather than measuring a single sympathetic response it is more likely measuring a bundle of physiological reactions to arousal which may be found to be more reliable and more difficult to control through training.

A new area of research for the GDV that we find particularly interesting is the investigation into life style as a coping response to the pressures of our modern world. Individuals in our Unwinding sub-sample in Study 1 seem to have voluntarily chosen particularly effective methods to reduce stress and anxiety. Perhaps alcohol, smoking and eating, along with activities such as reading, listening to music, country walks and prayer and so on are methods which we unknowingly use to control the level of stress and anxiety in our daily lives.

Lastly, in the medical field it would be interesting to explore, for example, the possible links between the GDV and diabetes for if our hypothesis about the relationship between the GDV and energy storage and release are correct one would expect to find that diabetics have weaker GDV images than non-diabetics. Similarly, if our hypothesis about the link between the GDV and arousal and mental concentration are correct then attention deficit hyperactivity disorder (ADHD) might also be a fruitful subject for future research.

Most of the research above can be undertaken with alternatives to the GDV technique. We can measure blood pressure, heart rate, glucose levels, oxygen levels, skin conductivity, body temperature and analyze blood and urine samples and so on. But these can be time consuming and costly and most require medical supervision. We can ask people how they are feeling. But our research suggests that the cognitive aspects that GDV reflects cannot be gained reliably by self-report. As medical practitioners can testify people are often unaware of the physical and psychological pressures they are under. The symptoms of stress such as eczema, high blood pressure, gastric ulcers, irritability, and impotence are likely to present themselves before the individual recognizes the cause. In contrast, the benefits of the GDV are that it is quick and simple to administer, non-invasive, appropriate for short interval time series analysis, cannot be faked, after training can be used by anybody and is relatively cheap.

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